Section 5
Preliminary Findings

Overview:

To determine the "appropriateness" of differing agricultural water use measurement strategies, it is necessary to look across the projected costs and expected benefits for each possible measurement improvement.

Such an analysis presents significant challenges. Most importantly, the analysis must develop credible strategies for analyzing the complexities of the state's current water measurement picture. Water managers measure at different locations using a virtually infinite combination of techniques to satisfy varying objectives, local conditions and needs. Additionally, measurement infers more than simply data generation; it encompasses how data is collected and managed. Finally, there are potentially important regional distinctions that must be catalogued and considered. Moreover, the analysis necessitates the comparison of quantitative costs with qualitative benefits.

To tackle these intricacies, the Technical Team undertook a region-by-region[1] analysis that collapsed the many different practices into 21 distinct agricultural measurement alternatives: the seven different measurement locations and three measurement intensities described earlier in these materials. As importantly, the Technical Team spent a great deal of time developing, discussing and refining this analysis. It also met with a number of regional experts to review the underlying cost and benefit characterizations.

Below is a summary of the most critical preliminary conclusions resulting from this analysis. These findings – focused on defining the appropriateness of measurement – are organized by the seven primary measurement locations: surface water diversions, groundwater use, crop consumption, return flow, water quality, stream gauging and farm-gate turnout. For each location, the analysis looks across the anticipated costs and benefits to: (1) identify and explain what the Technical Team is characterizing as an "appropriate" level of measurement; (2) identify and explain why other measurement intensities for that location do not appear "appropriate;" and, (3) highlight any region-specific distinctions or other implementation considerations.

In reviewing the preliminary conclusions presented below, it is important to keep the following points in mind:

- For the purpose of this analysis, measurement is defined as the generation, collection and management of data. Data is generated by a measurement method or device. Measurement also encompasses data collection, analysis, quality control and assurance, archiving and reporting. Put simply: For water use measurement to be

[1] For the purposes of this analysis, the Technical Team's regional analysis looked at six distinct areas: Sacramento Valley, Delta, Eastside San Joaquin Valley, Westside San Joaquin Valley, Southern San Joaquin Valley, other California. These regions are described elsewhere the section on measurement objectives and components.

useful, the collected information must be made available to people who need that information.

- "Appropriateness" is based on the Technical Team's analysis of the quantitative costs and qualitative benefits associated with generating, collecting and managing data. It does not encompass costs and benefits associated with related district- or on-farm water management changes. (While the Technical Team recognizes the value of incorporating project-specific costs and benefits into the current analysis, the Technical Team concludes it is not feasible to credibly anticipate and quantify local actions at this time.)

- "Appropriateness" is based on the Technical Team's analysis of the quantitative costs and qualitative benefits associated with altering *current* measurement approaches. The Technical Team recognizes that the characterization of these costs and benefits will likely change over time and must be accounted for in any implementation approach.

- The Technical Team further recognizes that, in cases where the analysis suggests the "appropriateness" is sensitive to slight changes in costs or benefits, basin or project-specific cost and benefit analyses may be warranted to confirm appropriateness.

- The analysis does not attempt to address the issue of who pays for changes in current measurement approaches, as that question is expected to be addressed in post-Panel deliberations. The Technical Team further expects that any approach will be grounded in CALFED's principle of beneficiary pays; in other words, locals would be responsible for covering only locally cost-effective actions.

- The analysis is presented as a statewide summary. It was developed, however, based on a regional assessment intended to account for local differences in baseline conditions and anticipated costs and benefits.

Findings:

Below is a summary of the key preliminary findings. These findings are summarized by each of the seven primary measurement locations.

Surface Water Diversions

Surface water diversions represent surface water supplies that are taken by water suppliers or individual growers from rivers, lakes, reservoirs or large multi-district canals. The three levels of measurement intensity associated with surface water diversion are:

· Basic: Estimate flow rates for water delivery structures once per year. Track delivery duration and use flow estimates to calculate volume delivered.

· High: Inventory and rate structures. Measure flow rates, on average, three times daily per structure use.

· Highest Technically Practical: Inventory and rate structures. Install flow totalizing devices, data loggers, and telemetry.

The analysis suggests that roughly 4% of surface water diversions statewide are currently measured at the basic intensity level, 16% are at high, and 80% are at highest technically practical. There are some slight regional variations. In the Sacramento Valley, the number of water suppliers at the basic and high levels are slightly greater than elsewhere. This distinction accounts for most of the variation in the state.

Based on the baseline condition outlined above and the Technical Team's analysis of expected benefits and costs associated with changes to the current measurement approach, the Technical Team puts forward the following preliminary findings:

- Most diversions statewide are currently measured at "high." This level is unable to provide the accuracy needed to credibly resolve water rights disputes or determine water availability.

- Upgrading surface water diversions to "highest technically practical" is appropriate statewide because it: (1) enables a more efficient and effective review and approval of water rights applications, transfers and dispute resolutions; (2) enables more effective planning (i.e., Bulletin 160 forecasting); and (3) represents an incremental, low-cost change from current approach.

- The analysis suggests that upgrading all surface water diversions to "highest technically practical" would cost on an annual basis roughly $100,000/yr, or about $0.01 per acre if averaged across statewide irrigated acreage. Costs are not evenly distributed across analysis regions, however. Roughly 70% of the statewide cost would occur within the Sacramento Valley. Most of the balance would occur on the Eastside of the San Joaquin Valley.

- Implementing agencies should consider threshold cutoffs for small riparian users. Although the extent of small riparian diversions is unknown, it is assumed that they represent only a minor user of water.

Groundwater Use

Groundwater use represents the net use of groundwater by individual growers or water suppliers. The three levels of measurement intensity associated with groundwater use are:

· Basic: Closure factor after estimating crop water consumption, surface water deliveries and surface return flows.

· High: Regional characterization of groundwater volume using two methods: detailed sub-basin hydrologic balance and water table method.

· Highest Technically Practical: Totalizing flow meters or pump testing coupled with an estimate of the surface runoff and deep percolation of the pumped water. Install flow totaling devices, data loggers, and telemetry.

The analysis suggests that roughly 28% of groundwater wells dedicated to agricultural uses currently have totalizing flow meters. Information about the volume pumped, in nearly all instances, stays with the well owner. There are a few sub-basins with detailed groundwater budgets developed by local water suppliers or governments. Most sub-basins in the State are measured at the “basic” level with the information self-reported for Bulletins 160 and 118.

Based on the baseline condition outlined above and the Technical Team’s analysis of expected benefits and costs associated with changes to the current measurement approach, the Technical Team puts forward the following preliminary findings:

- Most groundwater use is currently estimated from surface water deliveries, crop ET and self-reported B118 data. The consistency and reliability of data generated through this approach is unknown. Most existing adjudicated basins rely on self-imposed measurement, using totalizing flow meters, with data reported to a local water master..

- Upgrading groundwater use to “high” statewide appears appropriate as it is expected to generate more reliable and consistent net groundwater use data. Additionally, it will help identify potential conjunctive use opportunities and provide an independent check that the State role in not allocating groundwater is appropriate.

- The analysis suggests that the cost on an annual basis of upgrading measurement of groundwater use to “high” is roughly $2 million per year, or about $0.25 per acre. Regional cost differences are a function of the size of the groundwater sub-basins within a region.

- Though “highest technically practical” measurement is capable of generating significantly better data (both in detail and reliability), the cost associated with this level of measurement appears warranted only in adjudicated basins (through a locally driven effort) or if the state opts to aggressively allocate groundwater. The cost analysis suggests the cost on an annual basis of moving all groundwater use measurement to “highest technically practical” is roughly $22 million per year, or about $3 per acre. Per acre costs are highest in the Sacramento Valley and Delta analysis regions, where the proportion of metered wells to total wells is lowest. In these two regions, costs average about $3.25 per acre; in the other regions, costs average closer to $2.50 per acre.

- Measuring groundwater use and crop consumption at the “high” level along with measuring surface water diversions at the “highest technically practical” level will significantly improve the accuracy of water balance calculations. Moving all groundwater wells to the highest technically practical level will provide the user with more information regarding water use that can subsequently be used to improve on-farm management.

Crop Consumption

Crop consumption represents water flowing to the atmosphere through crop evaporation or transpiration. The three levels of measurement intensity associated with crop consumption are:

- Basic: Based on a rolling (every five years) inventory of crop acreage, average evapotranspiration (ET) data (for example through CIMIS) and existing crop coefficients.

- High: Remote sensing using multi-spectrum satellites images referred to as- LANDSAT 7 on a monthly time step with a 30m resolution during the growing season.

- Highest Technically Practical: Remote sensing using multi-spectrum satellites images referred to as- LANDSAT 7 based on a 16 day (highest frequency of LANDSAT 7 flyover) time step during the growing season with a 30 m resolution.

Statewide, crop consumption is currently measured using the basic intensity outlined above. Differences in the methods used by the DWR district offices to report crop water consumption account for regional differences.

Given the baseline condition outlined above and the Technical Team's analysis of expected benefits and costs associated with changes to the current measurement approach, the Technical Team puts forward the following preliminary findings:

- The vast majority of data is currently developed using theoretical crop-consumption estimates based on rolling five-year intervals. This approach results in indirect measurement with unknown accuracy.

- Upgrading measurement to "high" – in other words, remote sensing based on a monthly time-step – appears warranted statewide as it is a direct measurement of crop water consumption. The improved data will lead to vastly improved water balance calculations, since crop consumption represents approximately 65% of consumptive water use in California.

- The analysis suggests that the total cost on an annual basis of upgrading measurement of crop consumption use to "high" is roughly $0.5 million per year, or about $0.06 per acre. Cost differences are based on land area changes across regions.

- The analysis suggests that upgrading crop consumption measurement to "highest technically practical" is not warranted, as it is not expected to yield a meaningful improvement in information value over "high." Moreover, such a shift would represent an increase in cost, hiking per-acre costs by a third to about $0.08 per acre.

- Though the effectiveness of remote sensing has been demonstrated in some areas, given the limited application of this new technology, implementing agencies should carefully track the effectiveness of this approach to identify unexpected cost or effectiveness considerations

- Measuring crop consumption and groundwater use at the "high" level along with measuring surface water diversions at the "highest technically practical" level will significantly improve the accuracy of water balance calculations.

Return Flow

Return flow represents water returned to public water bodies (lakes, streams, regional canals) downstream of irrigation diversions. For the purpose of this analysis, return flow points were defined as major drains where return flow water may originate from district spills, surface runoff or subsurface drainage. The three levels of measurement intensity associated with return flow are:

· Basic: Estimate flow rates for water delivery structures once per year. Track delivery duration and use flow estimates to calculate volume delivered.

· High: Inventory and rate structures. Measure flow rates, on average, three times daily per structure use.

· Highest Technically Practical: Rely on inventory and rate structures. Install flow totaling devices, data loggers, and telemetry.

It is not possible to currently characterize baseline measurement of return flow, as data is diffuse.

Based on the Technical Team's analysis of expected benefits and costs associated with changes to the current measurement approach, the Technical Team puts forward the following preliminary findings:

- There is currently no systematic approach statewide for measuring return flows nor does a new statewide approach seem warranted, given the extremely place-specific water transfer and water availability needs associated with this data.

- In some instances – for example, when there is a need for better monitoring and prevention of third-party water-user impacts or better water balances – it may be conditionally appropriate to upgrade measurement of return flows to "highest technically practical." In those instances where better data is needed, "high" is not good enough due to the highly variable nature of return flows.

- Given the uncertainty about the number of existing return points and the place- and condition-specific needs associated with return flow measurement, it is not possible to project meaningful statewide or per-acre costs for return flow measurement at this time.

- Sufficient background information for return flow locations was not available in a comprehensive and consistent manner. However, there was a consensus among the individuals contacted for interviews that there is insufficient measurement information for return flow locations.

- Return flow information improves the overall water balance by providing more detail about local activities that contribute to public waterways. Also due to the connection with public waterways, there is a strong tie between stream gauging, water quality and return flows. This information can also be used to support water quality investigations and TMDL development.

- The analysis suggests that additional baseline data is required to assess measurement needs for statewide planning and water use efficiency purposes. Accordingly, implementing agencies should review existing programs and efforts to determine additional statewide measurement needs, if any, associated with objectives such as water quality, quantifiable objectives and stream loading.

Water Quality

Water quality represents a dimension of measurement that is used to establish the useful capacity or impairment of water (both surface and groundwater). The three levels of measurement intensity associated with water quality are:

- Basic: Ad-hoc samples taken without a scheduled sampling interval.

- High: Frequency of sampling prescribed by protocol and constituent of concern. This covers constituents for which there are no existing sampling devices that can directly measure the target constituents. (or example, selenium sampling from the Westside of the San Joaquin Valley using a predetermined sampling interval).

- Highest Technically Practical: Frequency of sampling prescribed by protocol and constituent of concern. Applies to constituents that can be measured on a continuous basis (dissolved oxygen, conductivity, pH, turbidity and temperature) using a device that directly measures the constituent.

The place- and constituent-specific nature of water quality measurement makes it difficult to characterize the current state of measurement. In addition, there are a multitude of discretely monitored sites that operated for specific time periods. In many cases the water quality information collected is not housed in a publicly accessible manner.

Based on the baseline condition outlined above and the Technical Team’s analysis of expected benefits and costs associated with changes to the current measurement approach, the Technical Team puts forward the following preliminary findings:

- Currently all three measurement levels are used for monitoring in-stream, return flow and groundwater quality. The specific approach is driven by local and state needs.

- Like return flows, given the largely place- and constituent-specific needs associated with water quality monitoring and the current understanding of water quality measurement protocols, no statewide upgrade to measurement is considered appropriate at this time.

- Given the place- and condition-specific needs associated with water quality measurement described above, it is not possible to project meaningful statewide or per-acre costs for water quality measurement at this time.

- Water quality information improves the overall water balance by providing more detail about local activities that contribute to public waterways. Also due to the connection with public waterways, there is a strong tie between stream gauging, water quality and return flows. This information can also be used to support water quality investigations and TMDL development.

- To further refine statewide data needs, implementing agencies should survey the current measurement of groundwater, surface water streams and agricultural point-source return. More baseline data is needed.

Stream Gauging

Stream gauging represents stream or drainage-way measurement sites that provide flow and water quality information. The three levels of measurement intensity associated with stream gauging are:

- Basic: Continuous water level measurement of a cross section that is surveyed annually (eg., annual update of stage-flow rating).

- High: Continuous water level measurement, of a cross section that is surveyed monthly.

- Highest Technically Practical: Continuous water level measurement, of a rated control section consistent with the USGS criteria.

The analysis suggests that stream gauging statewide is currently measured at either the high level (30%) or the highest technically practical (70%) level. Little, if any, measurement occurs at the basic level. Regional differences are due primarily to the lack of stream gauging stations in some regions.

Based on the baseline condition outlined above and the Technical Team's analysis of expected benefits and costs associated with changes to the current measurement approach, the Technical Team puts forward the following preliminary findings:

- Currently only the two highest levels of measurement are used for stream gauging. It is unclear if the current measurement approach is sufficient to support planning and water balance objectives. Although many resource managers in State and local agencies have indicated that more stream gauging stations are required, a comprehensive list of station needs does not exist.

- Any statewide upgrade in measurement approach is conditional based upon the state developing a better understanding of the reasonable distribution of measurement points. If warranted, upgrades are expected to focus on "high" or "highest technically practical" since "basic" does not generate sufficient quality data for water balances or water availability and water transfer issues.

- The analysis suggests that costs on an annual basis associated with stream gauging ranges from \$10,000 to \$20,000 per station. However, the given the limited understanding associated with stream gauge measurement described above, it is not possible to project meaningful statewide or per-acre costs for stream flow measurement as it relates to agricultural water uses at this time.

- Stream gauging information improves the overall water balance by providing more detail about local activities that contribute to public waterways. Also due to the connection with public waterways, there is a strong tie between stream gauging, water quality and return flows. This information can also be used to support water quality investigations and TMDL development.

- Implementing agencies should review existing programs and efforts to better determine the minimum acceptable distribution of measurement points.

Farm-Gate Deliveries

Farm-gate deliveries – also referred to as "turnouts" – represent the delivery of surface water from a water supplier to individual customers. The three levels of measurement intensity associated with farm-gate deliveries are:

- Basic: Estimate flow rates for turnout structures once per year. Track delivery duration and use flow estimates to calculate volume delivered.

- High: Inventory and rate structures. Measure flow rates, on average, three times daily per structure use.

- Highest Technically Practical: Inventory and rate turnout structures. Install flow totaling devices, data loggers, and telemetry.

The analysis suggests that roughly 3% of farm-gate deliveries statewide are currently measured at the basic intensity level, 59% at high, and 38% at highest technically practical. Regional variations are the greatest for this measurement location. The Sacramento Valley and the Eastside of the San Joaquin Valley have more of the basic level of measurement, whereas the other regions of the State have a greater amount of high and highest technically practical farm-gate deliveries.

Based on the baseline condition outlined above and the Technical Team's analysis of expected benefits and costs associated with changes to the current measurement approach, the Technical Team puts forward the following preliminary findings:

- Currently, all three levels are used to measure farm-gate deliveries, though most farm-gate delivery infrastructure is capable of generating "high" or "highest technically practical" data. However, discussions with local, state and federal representative suggest varied on-farm use of the infrastructure capabilities. In other words, while the infrastructure may be in place, it appears that many water users are not collecting or using the data or reconfirming the accuracy of the measurement devices.

- Regardless of the method or device being used, it is important to foster more uniform use of existing infrastructure and generate more consistent data statewide. Reporting of aggregated data will assist statewide planning. Although this level does not represent an upgrade of farm-gate hardware, it does imply an increase in data collection and reporting activities for many water suppliers.

- If statewide policymakers decide to implement volumetric pricing or water use efficiency practices, more accurate farm-gate data is needed. The current "high" method used by many end users is sufficient and appropriate to inform such an approach; "basic" is not. The annual cost associated with shifting turnouts from "basic" to "high" is expected to range from $20 million to $30 million statewide or $25 to $35 per affected acre. For those that are at the "basic" level, a literature review suggests that that approach may be sufficient to mandate incentive (but not volumetric) pricing.

- The analysis suggests that "highest technically practical" measurement is cost prohibitive in most situations – on an annual basis cost estimates range by region from $10 million to $50 million and from $20 to $50 per affected acre[2] – and is not a necessary condition to support volumetric pricing. It is also not seen to be essential in meeting other state or federal water management objectives. Finally, in some localities, farm-gate measurement provides a poor approximation of field-level water consumption. This is especially true in regions that use flow-through irrigation where return flow from one field is used on another.

Conclusions:

Based on the analyses above, the Technical Team has identified four overarching elements of a definition of appropriate measurement. These elements are:

- ***Preliminary Conclusion One:*** There are a series of steps related to agricultural water use measurement that appear to make sense throughout the state. These are: (1) "highest technically practical" measurement of major surface water diversions; (2) "high" measurement of groundwater use; (3) "high" measurement of crop consumption; and, (4) at least " basic" measurement of farm-gate deliveries coupled

[2] Wide range is due to regional differences in number of turnouts that would need to be converted and acres served per turnout.

with effective data management. The technical analysis suggests that the Panel deem these "appropriate."

- ***Preliminary Conclusion Two:*** There is an additional series of steps related to agricultural water use measurement that might make sense, but are dependent on a more detailed and ongoing evaluation of place- or constituent-specific needs. These center on return flow, water quality and stream gauging. The technical analysis suggests that the Panel deem these "conditionally appropriate."

- ***Preliminary Conclusion Three:*** There are two steps related to agricultural water use measurement that might make sense, but only if they are coupled with other actions. These are:

  - "Highest technically practical" measurement of groundwater use, which only makes sense in locally initiated adjudicated basins or if the state opts to aggressively manage or allocate groundwater resources at the basin level; and,

  - "High" measurement of farm-gate deliveries, which may be appropriate if volumetric pricing or water use efficiency practices are implemented.

  Again, the technical analysis suggests that the Panel deem these "conditionally appropriate."

- ***Preliminary Conclusion Four:*** Any new approach to measurement must be adaptive and be structured in a manner that enables an evolving and nuanced definition of "appropriateness." Accordingly, any legislative or regulatory implementation strategy must be carefully crafted to account, for among other things:

  - The impact of evolving technologies, shifting attitudes, and changing costs and benefits on the appropriateness of different measurement strategies;

  - The need, in some instances, to undertake more project-specific cost - benefit analyses, particularly in those cases where implementation costs are high and there are locally unique costs and benefits; and,

  - The involvement of affected stakeholders in designing implementation approaches that account for local sensitivities and differences.

Additionally, a review of six other states' approach to agricultural water use measurement suggests three additional implementation considerations to keep in mind. They are:

- First, any specific requirement that agricultural water use be measured must always be associated with an appropriate set of available exemptions, variances, and "second best" approaches.

- Second, when establishing any requirement that agricultural water use be measured, it is equally important to focus on how measurement "data" will be turned into "information" that is useful to governmental and private actors.

- Third, when designing an approach to agricultural water use measurement, it is important to focus on the labor-intensive nature of the undertaking, including but not limited to the direct relationship between the number of points within the system that are being measured and the resulting agency staffing burden.

The Technical Team looks forward to discussing its findings and conclusions with the Panel.